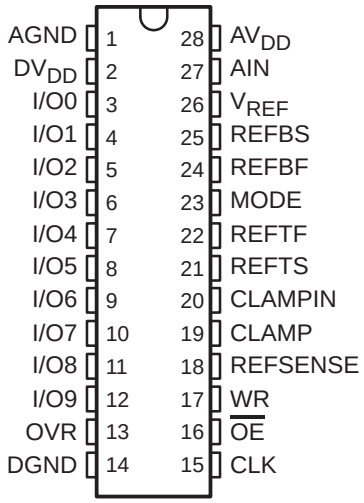
- **10-Bit Resolution 30 MSPS Analog-to-Digital Converter:**
- **Configurable Input Functions:**
  - **Single-Ended**
  - **Single-Ended With Analog Clamp**
  - **Single-Ended With Programmable Digital Clamp**
  - **Differential**
- **Built-in Programmable Gain Amplifier (PGA)**
- **Differential Nonlinearity: ±0.3 LSB**
- **Signal-to-Noise: 56 dB**
- **Spurious Free Dynamic Range: 60 dB**
- **Adjustable Internal Voltage Reference**
- **Straight Binary/2s Complement Output**
- **Out-of-Range Indicator**
- **Power-Down Mode**

28-PIN TSSOP/SOIC PACKAGE
(TOP VIEW)



description

The THS1031 is a CMOS, low power, 10-bit, 30 MSPS analog-to-digital converter (ADC) that can operate with a supply range from 2.7 V to 3.3 V. The THS1031 has been designed to give circuit developers more flexibility. The analog input to the THS1031 can be either single-ended or differential. This device has a built-in clamp amplifier whose clamp input level can be selected from an external dc source or from an internal high-precision 10-bit digital clamp level programmable via an internal CLAMP register. A 3-bit PGA is included to maintain SNR for small signal. The THS1031 provides a wide selection of voltage reference to match the user's design requirements. For more design flexibility, the internal reference can be bypassed to use an external reference to suit the dc accuracy and temperature drift requirements of the application. The out-of-range output is used to monitor any out-of-range condition in THS1031's input range. The format of digital output can be coded in either straight binary or 2s complement.

The speed, resolution, and single-supply operation of the THS1031 are suited for applications in set-top-box (STB), video, multimedia, imaging, high-speed acquisition, and communications. The built-in clamp function allows dc restoration of video signal and is suitable for video application. The speed and resolution ideally suit charge-couple device (CCD) input systems such as color scanners, digital copiers, digital cameras, and camcorders. A wide input voltage range between REFBS and REFTS allows the THS1031 to be applied in both imaging and communications systems

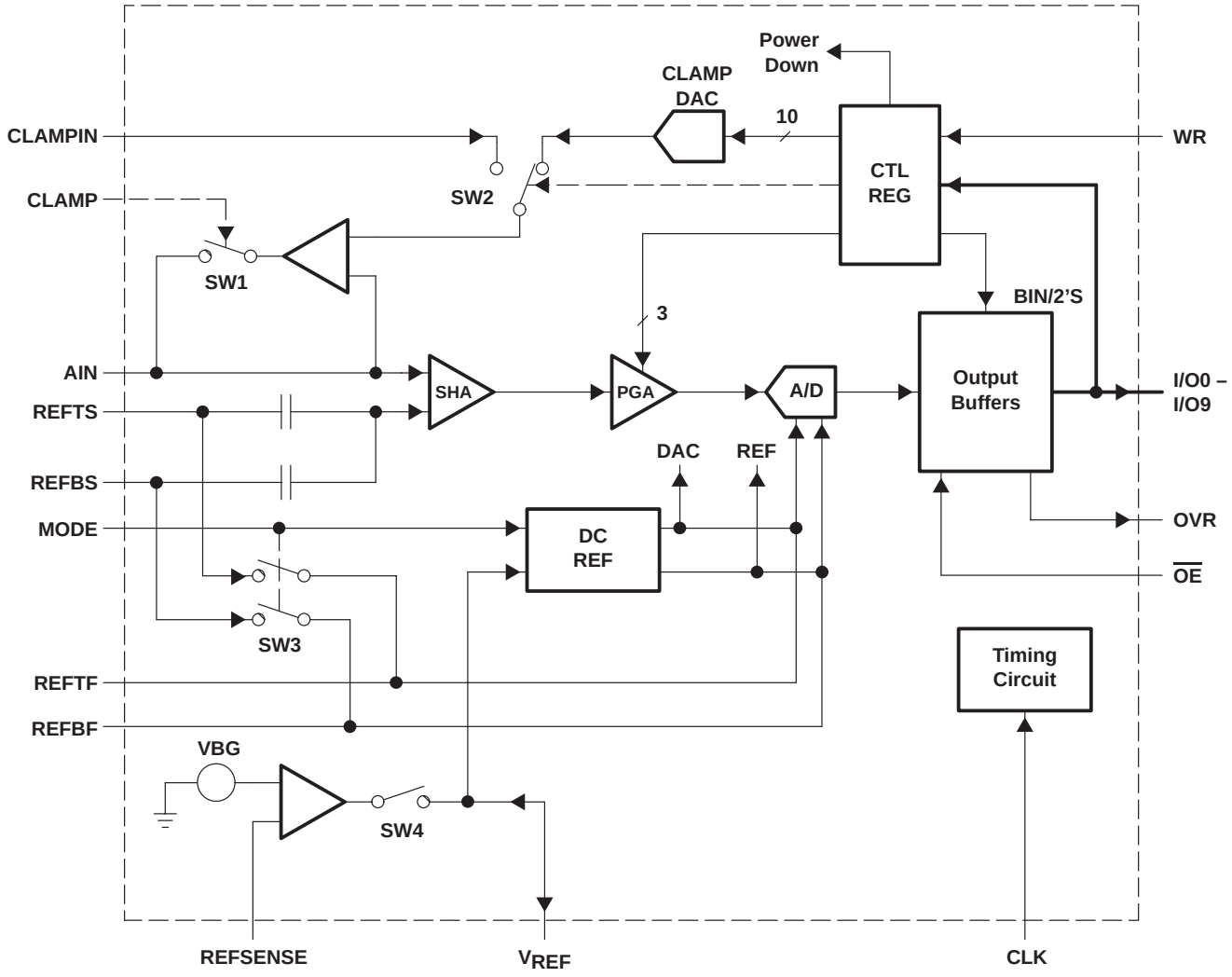
The THS1031I is characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES	
	28-TSSOP (PW)	28-SOIC (DW)
0°C to 70°C	THS1031CPW	THS1031CDW
–40°C to 85°C	THS1031IPW	THS1031IDW

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

functional block diagram



Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
AGND	1	I	Analog ground
AIN	27	I	Analog input
AV_{DD}	28	I	Analog supply
CLAMP	19	I	HI to enable CLAMP mode, LO to disable CLAMP mode
CLAMPIN	20	I	Connect to an external analog clamp reference input.
CLK	15	I	Clock input
DGND	14	I	Digital ground
DV_{DD}	2	I	Digital driver supply
I/O0	3	I/O	Digital I/O bit 0 (LSB)
I/O1	4		Digital I/O bit 1
I/O2	5		Digital I/O bit 2
I/O3	6		Digital I/O bit 3
I/O4	7		Digital I/O bit 4
I/O5	8		Digital I/O bit 5
I/O6	9		Digital I/O bit 6
I/O7	10		Digital I/O bit 7
I/O8	11		Digital I/O bit 8
I/O9	12		Digital I/O bit 9 (MSB)
MODE	23	I	Mode input
$\overline{OE}$	16	I	HI to the 3-state data bus, LO to enable the data bus
OVR	13	O	Out-of-range indicator
REFBS	25	I	Reference bottom sense
REFBF	24	I	Reference bottom decoupling
REFSENSE	18	I	Reference sense
REFTF	22	I	Reference top decoupling
REFTS	21	I	Reference top sense
V_{REF}	26	I/O	Internal and external reference for ADC
WR	17	I	Write strobe goes HI to write data value D0:D9 to the internal registers.

absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply voltage: AV_{DD} to AGND, DV_{DD} to DGND . . . . . –0.3 to 6.5 V
AGND to DGND . . . . . –0.3 to 0.3 V
AV_{DD} to DV_{DD} . . . . . –6.5 to 6.5 V
Mode input MODE to AGND . . . . . –0.3 to AV_{DD} + 0.3 V
Reference voltage input range REFTF, REFTB, REFTS, REFBS to AGND . . . . . –0.3 to AV_{DD} + 0.3 V
Analog input voltage range AIN to AGND . . . . . –0.3 to AV_{DD} + 0.3 V
Reference input V_{REF} to AGND . . . . . –0.3 to AV_{DD} + 0.3 V
Reference output V_{REF} to AGND . . . . . –0.3 to AV_{DD} + 0.3 V
Clock input CLK to AGND . . . . . –0.3 to AV_{DD} + 0.3 V
Digital input to DGND . . . . . –0.3 to DV_{DD} + 0.3 V
Digital output to DGND . . . . . –0.3 to DV_{DD} + 0.3 V
Operating junction temperature range, T_J . . . . . 0°C to 150°C
Storage temperature range, T_{STG} . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 in) from case for 10 seconds . . . . . 300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

recommended operating conditions

digital inputs

	MIN	NOM	MAX	UNIT
High-level input voltage, V_{IH}	2.4			V
Low-level input voltage, V_{IL}			0.2 x DV_{DD}	V

analog inputs

	MIN	NOM	MAX	UNIT
Analog input voltage, $V_{I(AIN)}$	REFBS		REFTS	V
Reference input voltage, $V_{I(VREF)}$	1		2	V
Reference input voltage, $V_{I(REFTS)}$	1		AV_{DD}	V
Reference input voltage, $V_{I(REFBS)}$	0		AV_{DD}–1	V
Clamp input voltage, $V_{I(CLAMPIN)}$	REFBS		REFTS	V

power supply

			MIN	NOM	MAX	UNIT
Supply voltage	Maximum sampling rate = 30 MSPS	AV_{DD}	2.7	3	5.5	V
		DV_{DD}	2.7	3	5.5	

REFTS, REFBS reference voltages (MODE = AV_{DD})

	PARAMETER	MIN	TYP	MAX	UNIT
REFTS	Reference input voltage (top)	1		AV_{DD}	V
REFBS	Reference input voltage (bottom)	0		AV_{DD}–1	V
	Differential input (REFTS – REFBS)	1		2	V
	Switched input capacitance on REFTS		0.6		pF
	Switched input capacitance on REFBS		0.6		pF

sampling rate and resolution

PARAMETER	MIN	NOM	MAX	UNIT
Fs	5		30	MHz
Resolution		10		Bits

electrical characteristics, AV_{DD} = 3 V, DV_{DD} = 3 V, Fs = 30 MSPS/50% duty cycle, MODE = AV_{DD}, 2 V input span from 0.5 V to 2.5 V, external reference, PGA = 1X, T_A = –40°C to 85°C (unless otherwise noted)

analog inputs

PARAMETER		MIN	TYP	MAX	UNIT
$V_{I(AIN)}$	Analog input voltage	REFBS		REFTS	V
C_I	Switched input capacitance		1.2		pF
FPBW	Full power BW (–3 dB)		150		MHz
	DC leakage current (input = ±FS)		100		µA

REFTF, REFBF reference voltages

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
Differential input (REFTF – REFBF)			1		2	V
Input common mode (REFTF + REFBF)/2		AV_{DD} = 3 V	1.3	1.5	1.7	V
		AV_{DD} = 5 V	2	2.5	3	
REFTF (MODE = AV_{DD})	V_{REF} = 1 V	AV_{DD} = 3 V		2		V
		AV_{DD} = 5 V		3		
	V_{REF} = 2 V	AV_{DD} = 3 V		2.5		V
		AV_{DD} = 5 V		3.5		
REFBF (MODE = AV_{DD})	V_{REF} = 1 V	AV_{DD} = 3 V		1		V
		AV_{DD} = 5 V		0.5		
	V_{REF} = 2 V	AV_{DD} = 3 V		2		V
		AV_{DD} = 5 V		1.5		
Input resistance between REFTF and REFBF				600		Ω

V_{REF} reference voltages

PARAMETER	MIN	TYP	MAX	UNIT
Internal 1 V reference (REFSENSE = V_{REF})	0.95	1	1.05	V
Internal 2 V reference (REFSENSE = AV_{SS})	1.90	2	2.10	V
External reference (REFSENSE = AV_{DD})	1		2	V
Reference input resistance		18		kΩ

dc accuracy

PARAMETER		MIN	TYP	MAX	UNIT
INL	Integral nonlinearity		±1	±2	LSB
DNL	Differential nonlinearity		±0.3	±1	LSB
	Offset error		0.4	1.4	%FSR
	Gain error		1.4	3.5	%FSR
	Missing code	No missing code assured			

electrical characteristics, AV_{DD} = 3 V, DV_{DD} = 3 V, Fs = 30 MSPS/50% duty cycle, MODE = AV_{DD}, 2 V input span from 0.5 V to 2.5 V, external reference, PGA = 1X, T_A = –40°C to 85°C (unless otherwise noted) (continued)

dynamic performance (ADC and PGA)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ENOB	Effective number of bits	f = 3.5 MHz	8.2	9		Bits
		f = 3.5 MHz, AV_{DD} = 5 V		8.8		
		f = 15 MHz		7.7		
		f = 15 MHz, AV_{DD} = 5 V		7.64		
SFDR	Spurious free dynamic range	f = 3.5 MHz	55	60		dB
		f = 3.5 MHz, AV_{DD} = 5 V		63		
		f = 15 MHz		48		
		f = 15 MHz, AV_{DD} = 5 V		52.4		
THD	Total harmonic distortion	f = 3.5 MHz		–58.2	–54.7	dB
		f = 3.5 MHz, AV_{DD} = 5 V		–68.7		
		f = 15 MHz		–47		
		f = 15 MHz, AV_{DD} = 5 V		–51.9		
SNR	Signal-to-noise	f = 3.5 MHz	51.2	56		dB
		f = 3.5 MHz, AV_{DD} = 5 V		55		
		f = 15 MHz		53		
		f = 15 MHz, AV_{DD} = 5 V		49.3		
SINAD	Signal-to-noise and distortion	f = 3.5 MHz	51.1	56		dB
		f = 3.5 MHz, AV_{DD} = 5 V		55		
		f = 15 MHz		48.1		
		f = 15 MHz, AV_{DD} = 5 V		47.7		

PGA

PARAMETER	MIN	TYP	MAX	UNIT
Gain range (linear scale)	0.5		4	V/V
Gain step size (linear scale)		0.5		
Gain error from nominal			3%	
Number of control bits		3		Bits

clamp DAC

PARAMETER	MIN	TYP	MAX	UNIT
Resolution		10		Bits
DAC output range	REFBF		REFTF	
Clamping analog output voltage range	0.1		AV_{DD}–0.1	V
Clamping analog output voltage error	– 40		+ 40	mV

electrical characteristics, AV_{DD} = 3 V, DV_{DD} = 3 V, Fs = 30 MSPS/50% duty cycle, MODE = AV_{DD}, 2 V input span from 0.5 V to 2.5 V, external reference, PGA = 1X, T_A = –40°C to 85°C (unless otherwise noted) (continued)

clock

PARAMETER		MIN	TYP	MAX	UNIT
t_{CK}	Clock period	33			ns
t_{CKH}	Pulse duration, clock high	15	16.5		ns
t_{CKL}	Pulse duration, clock high	15	16.5		ns
t_d	Clock to data valid			25	ns
	Pipeline latency		3		Cycles
$t_{(ap)}$	Aperture delay		4		ns
	Aperture uncertainty (jitter)		2		ps

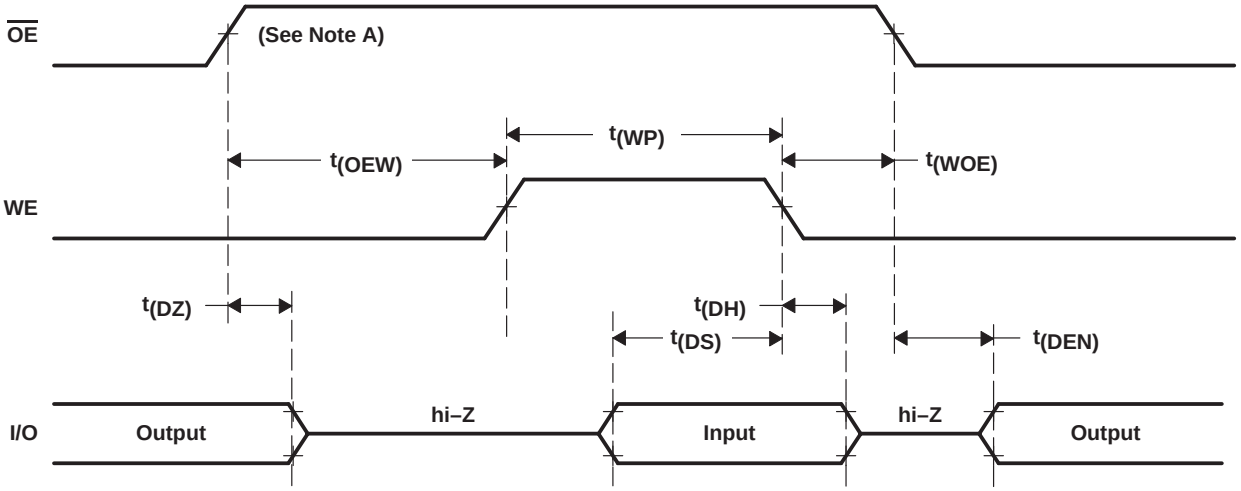
timing

PARAMETER		MIN	TYP	MAX	UNIT
$t_{(PZ)}$	Output disable to high-Z output	0		20	ns
$t_{(DEN)}$	Output enable to output valid	0		20	ns
$t_{(OEW)}$	Output disable to write enable	12			ns
$t_{(WOE)}$	Output disable to write enable	12			ns
$t_{(WP)}$	Write pulse	15			ns
$t_{(DS)}$	Input data setup time	5			ns
$t_{(DH)}$	Input data hold time	5			ns

power supply

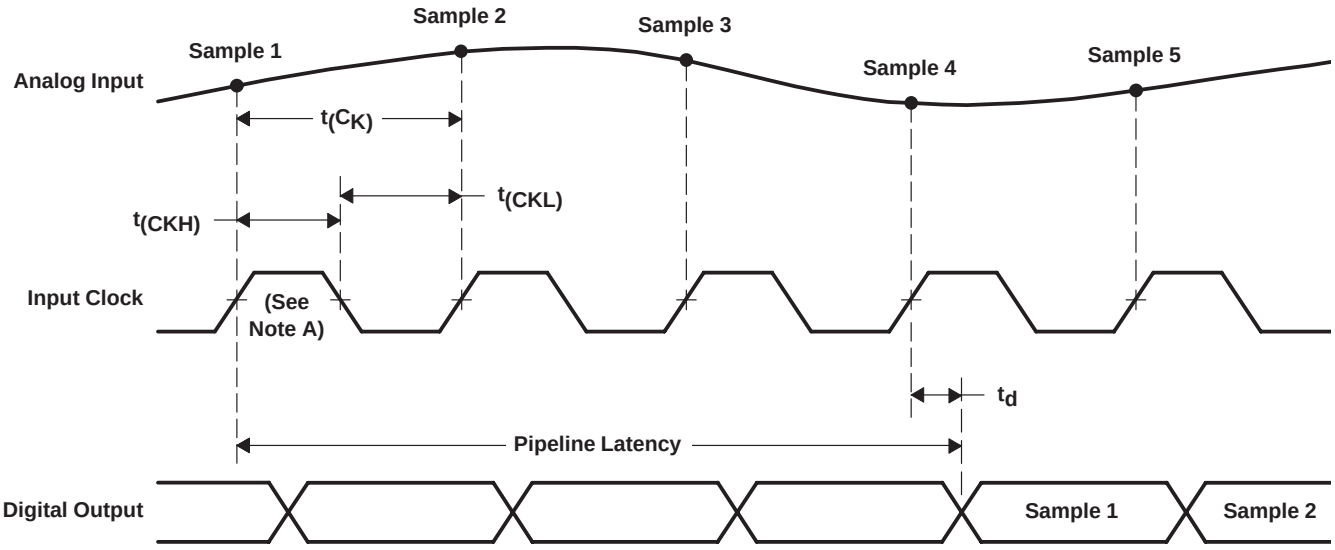
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{CC}	Operating supply current	AV_{DD} = 3 V, MODE = AGND		30.6	45	mA
P_D	Power dissipation	AV_{DD} = DV_{DD} = 3 V		94	135	mW
		AV_{DD} = DV_{DD} = 5 V		160		
P_D(STBY)	Standby power	AV_{DD} = DV_{DD} = 3 V, MODE = AGND		3	5	mW

PARAMETER MEASUREMENT INFORMATION



NOTE A: All timing measurements are based on 50% of edge transition.

Figure 1. Write Timing Diagram



NOTE A: All timing measurements are based on 50% of edge transition.

Figure 2. Digital Output Timing Diagram

TYPICAL CHARACTERISTICS

POWER DISSIPATION
vs
SAMPLING FREQUENCY

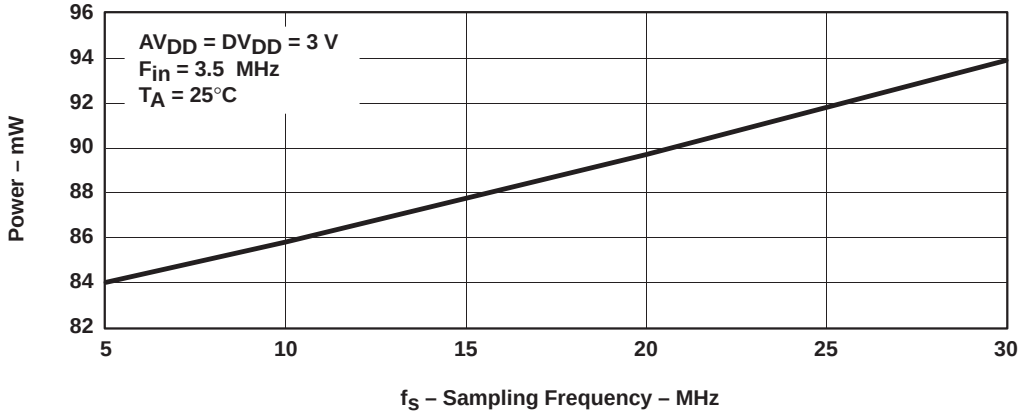


Figure 3

EFFECTIVE NUMBER OF BITS
vs
TEMPERATURE

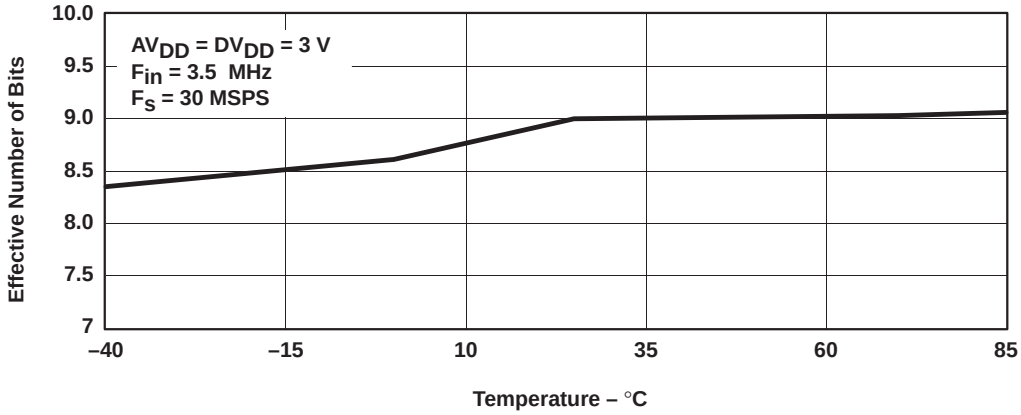


Figure 4

TYPICAL CHARACTERISTICS

EFFECTIVE NUMBER OF BITS vs FREQUENCY

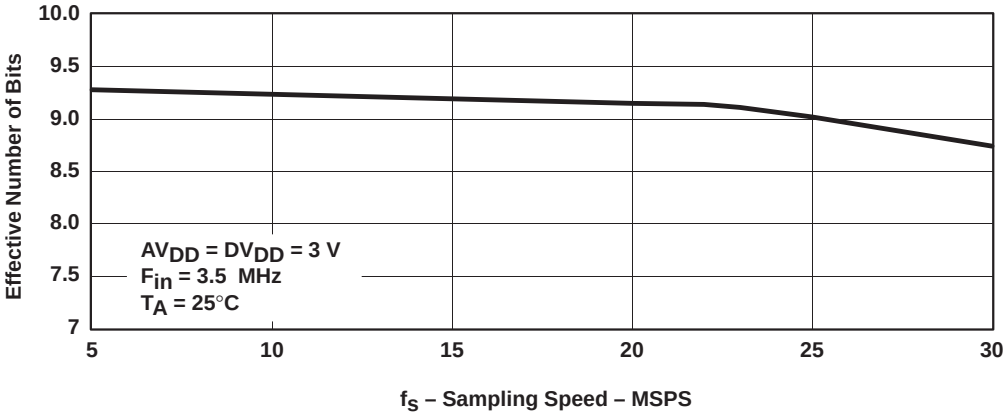


Figure 5

EFFECTIVE NUMBER OF BITS vs FREQUENCY

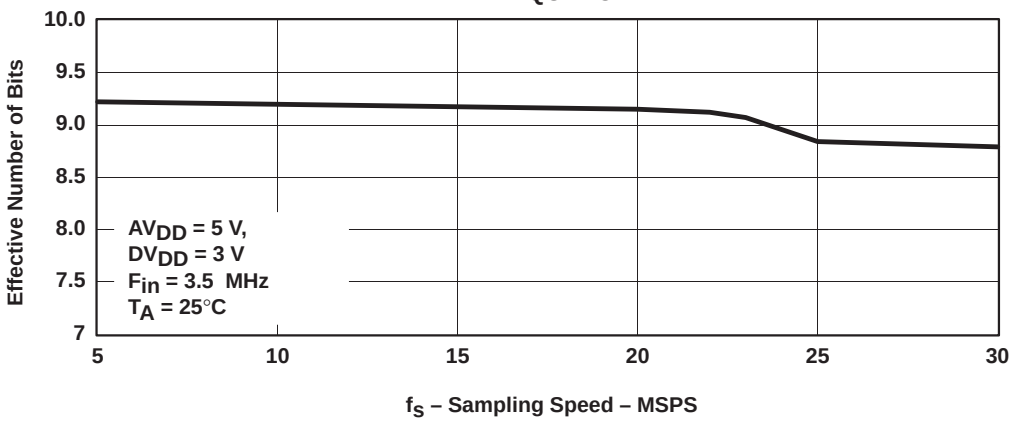


Figure 6

TYPICAL CHARACTERISTICS

EFFECTIVE NUMBER OF BITS vs FREQUENCY

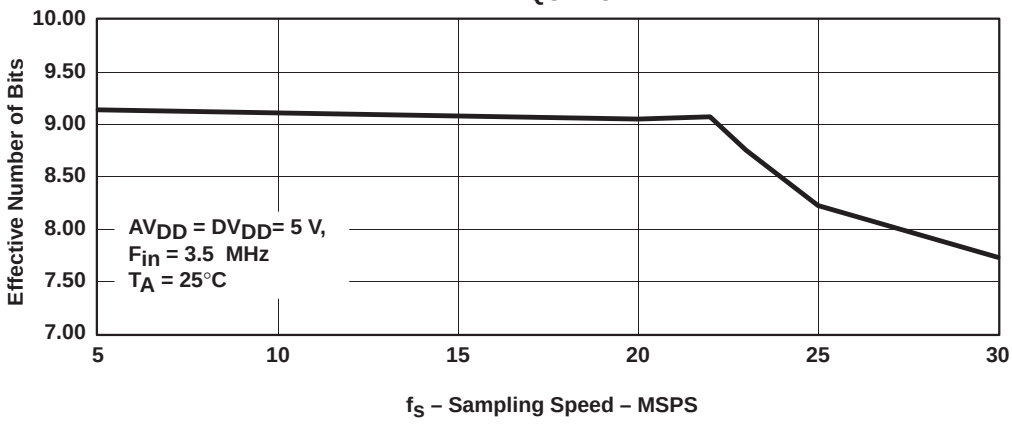


Figure 7

DIFFERENTIAL NONLINEARITY vs INPUT CODE

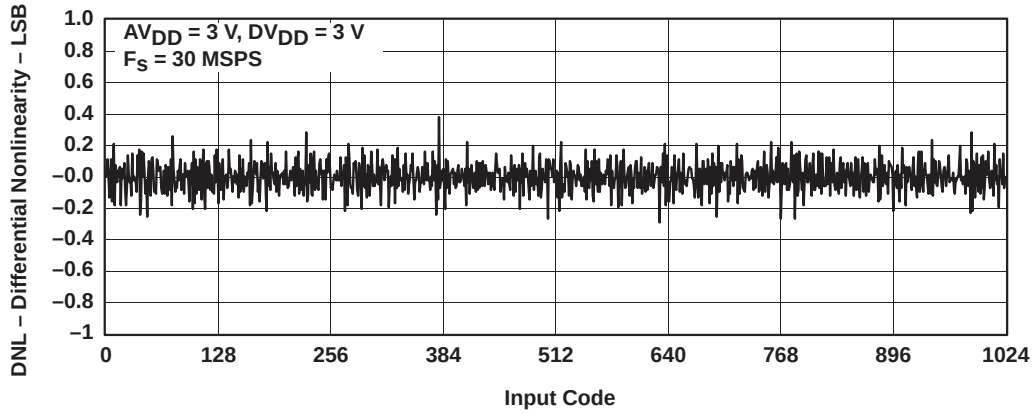


Figure 8

TYPICAL CHARACTERISTICS

INTEGRAL NONLINEARITY
vs
INPUT CODE

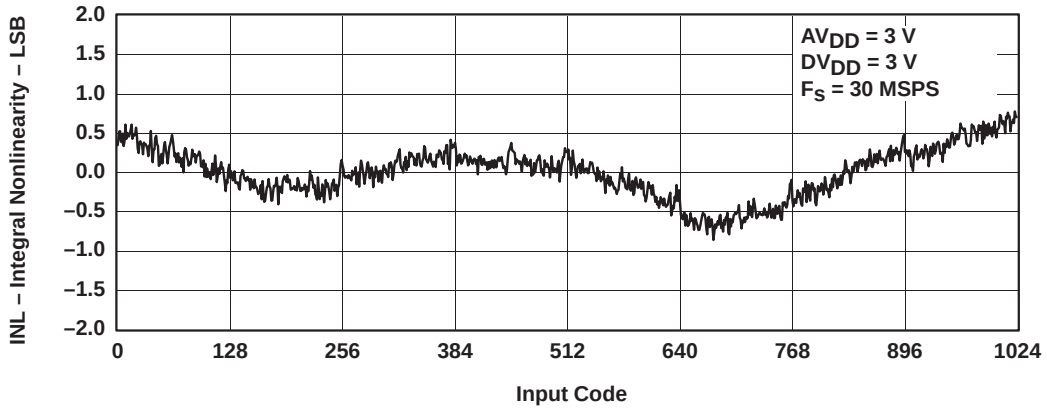


Figure 9

FFT
vs
FREQUENCY

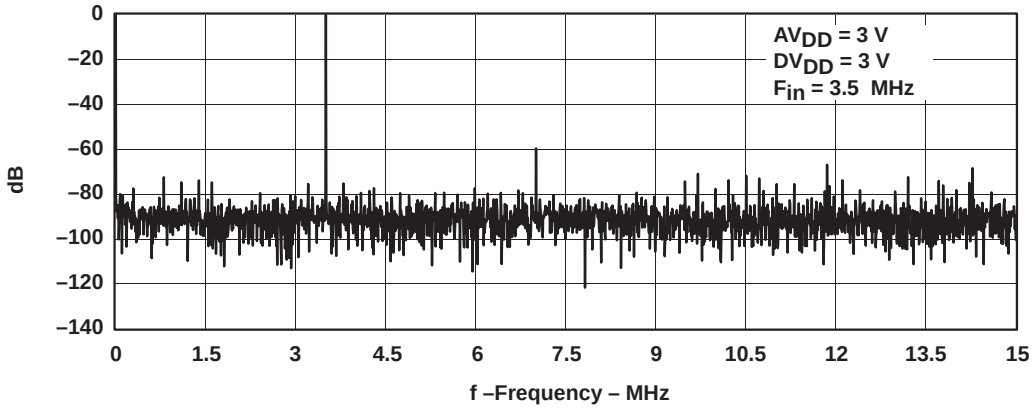


Figure 10

PRINCIPLES OF OPERATION

Table 1. Mode Selection

MODES	ANALOG INPUT	INPUT SPAN	MODE PIN	REFSENSE PIN	VREF PIN	REFTS PIN	REFBS PIN	FIGURE
Top/bottom	AIN	1 V	AV_{DD}	Short together			AGND	8, 15
	AIN	2 V	AV_{DD}	AGND	Short together		AGND	9, 16
	AIN	$1+R_a/R_b$	AV_{DD}	Mid R_a & R_b	Short together to R_a		AGND	10, 15, 16
	AIN	External V_{REF}	$AV_{DD}/2$	AV_{DD}	External	NC	AGND	10, 15, 16
Center span	AIN	1 V	$AV_{DD}/2$	Short together		Short together to the common mode voltage		8, 14
	AIN	2 V	$AV_{DD}/2$	AGND	NC			9, 14
	AIN	$1+R_a/R_b$	$AV_{DD}/2$	Mid R_a & R_b	R_a			10, 14
	AIN	V_{REF}	$AV_{DD}/2$	AV_{DD}	External			11, 14
External reference	AIN	2 V max	AGND	See Note 1	See Note 1	Voltage within supply (REFTS–REBS) = 2 V max		12, 13
Differential input	AIN is input 1 REFTS & REFBS are shorted together for input 2	1 V	$AV_{DD}/2$	Short together		Short together $AV_{DD}/2$		17
		2 V	$AV_{DD}/2$	AGND	NC			
		V_{REF}	$AV_{DD}/2$	AV_{DD}	External			

NOTE 1: In external reference mode, V_{REF} can be available for external use with CENTER SPAN setup.

reference operations

V_{REF}-pin reference

The voltage reference sources on the V_{REF} pin are controlled by the REFSENSE pin as shown in Table 2.

Table 2. V_{REF} Reference Selection

REFSENSE	V_{REF}
AGND	2 V
AV_{DD}	The internal reference is disabled and an external reference should be connected to V_{REF} pin if mode = $AV_{DD}/2$
Short to V_{REF}	1 V
Connect to R_a/R_b	$1+R_a/R_b$

PRINCIPLES OF OPERATION

reference operations (continued)

- 1-V reference: The internal reference may be set to 1 V by connecting REFSENSE to V_{REF}.

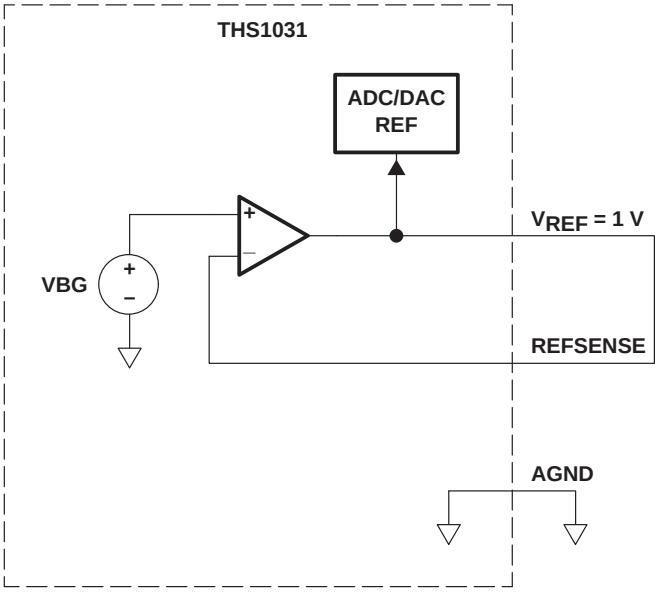


Figure 11. V_{REF} 1-V Reference Mode

- 2-V reference: The internal reference may be set to 2 V by connecting REFSENSE to AGND.

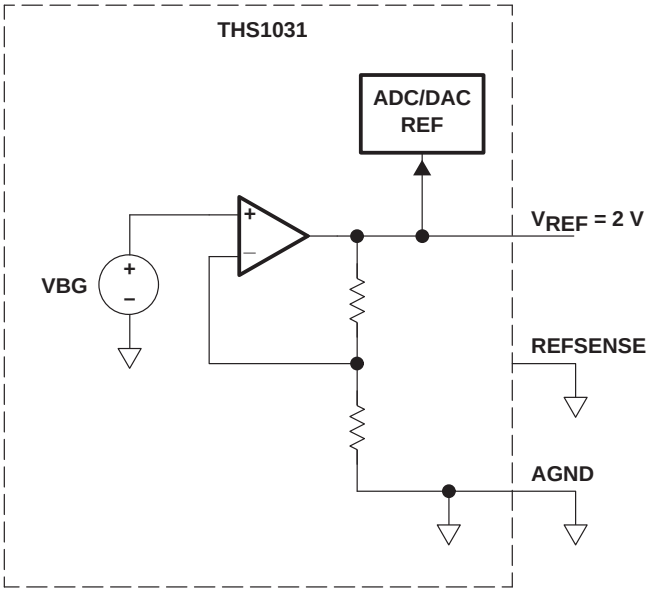


Figure 12. V_{REF} 2-V Reference Mode

PRINCIPLES OF OPERATION

reference operations (continued)

- External divider: The internal reference can be set to a voltage between 1 V and 2 V by adding external resistors.

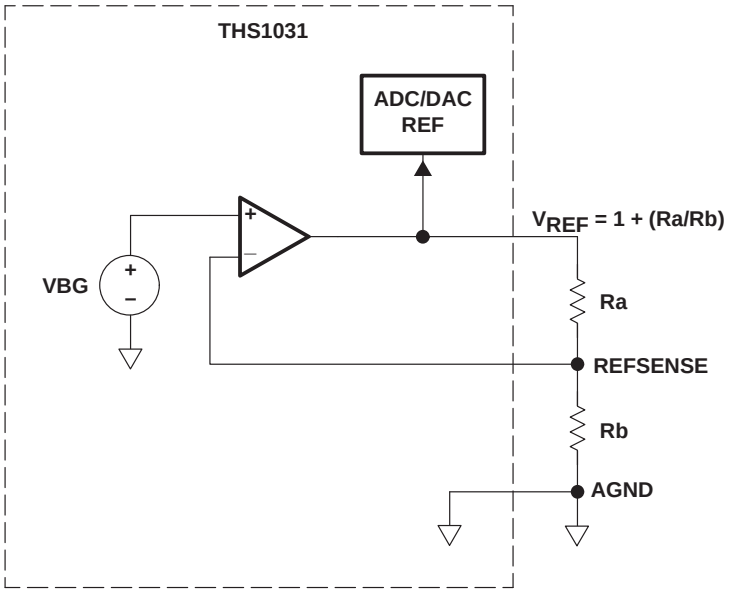


Figure 13. V_{REF} External Divider Reference Mode

- External reference: The internal reference may be overridden by using an external reference. This condition is met by connecting REFSENSE to AV_{DD} and an external reference circuit to the V_{REF} pin.

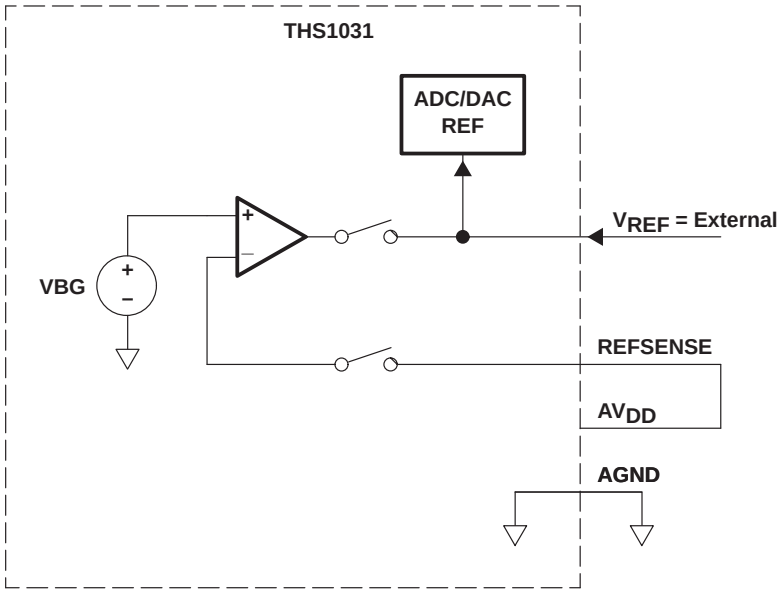


Figure 14. V_{REF} External Reference Mode

PRINCIPLES OF OPERATION

reference operations (continued)

ADC reference

The MODE pin is used to select the reference source for the ADC.

- **Internal ADC Reference:** Connect the MODE pin to AV_{DD} to use the reference source for ADC generated on the V_{REF} pin. (See V_{REF} REFERENCE described in Table 2) such that (REFTF–REFBF) = V_{REF} and (REFTF+REFBF)/2 is set to a voltage for optimum operation of the ADC (near $AV_{DD}/2$).
- **External ADC Reference:** To supply an external reference source to the ADC, connect the MODE pin to AGND. An external reference source should be connected to REFTF/REFTS and REFBF/REFBS. MODE = AGND closes internal switches to allow a Kelvin connection through REFTS/REFBS, and disables the on-chip amplifiers which drive on to the ADC references. Differential input is not supported

analog input mode

single-ended input

The single-ended input can be configured to work with either an external ADC reference or internal ADC reference.

- **External ADC Reference Mode**: A single-ended analog input is accepted at the AIN pin where the input signal is bounded by the voltages on the REFTS and REFBS pins. Figure 15 shows an example of applying external reference to REFTS and REFBS pins in which REFTS is connected to the low-impedance 2-V source and REFBS is connected to the low-impedance 2-V source. REFTS and REFBS may be driven to any voltage within the supply as long as the difference (REFTS – REFBS) is between 1 V and 2 V as specified in Table 2. Figure 16 shows an example of external-reference using a Kelvin connection to eliminate line voltage drop errors.

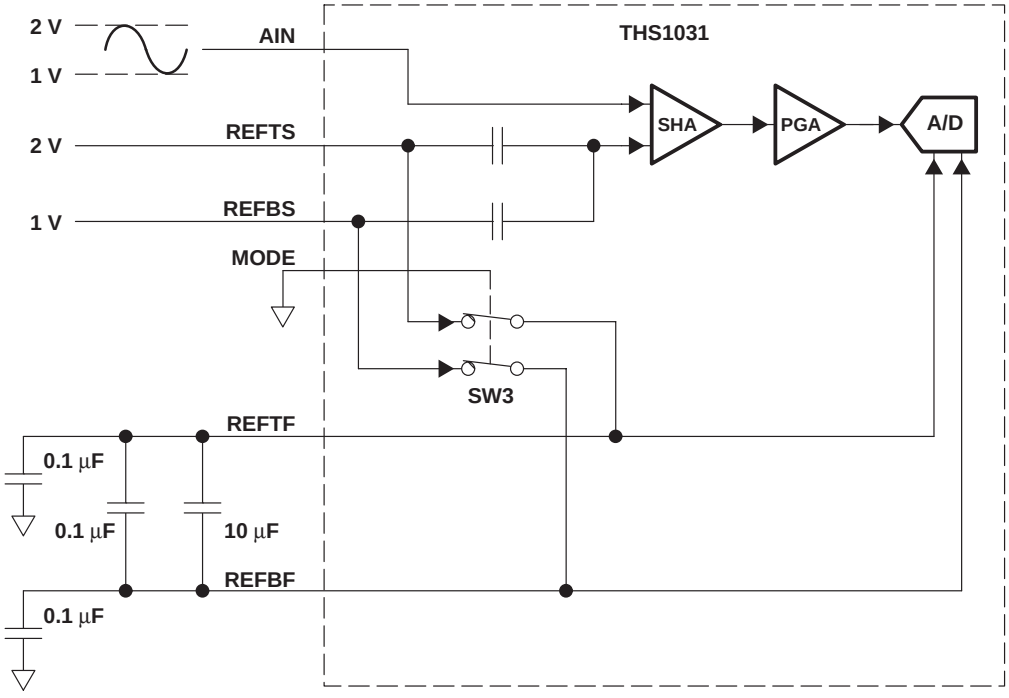


Figure 15. External ADC Reference Mode

PRINCIPLES OF OPERATION

analog input mode(continued)

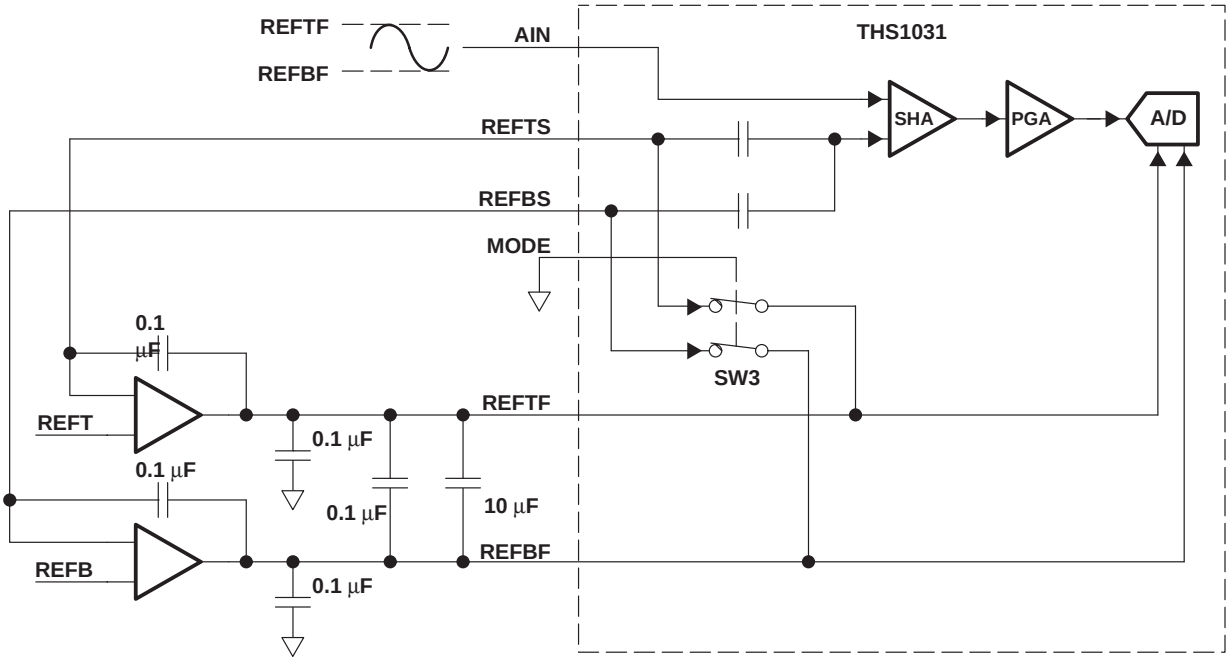


Figure 16. Kelvin Connection With External ADC Reference Mode

- **Internal ADC Reference Mode With External Input Common Mode**: The input common mode is supplied to pins REFTS and REFBS while connected together. The input signal should be centered around this common mode with peak-to-peak input equal to the voltage on the V_{REF} pin. Input can be either dc-coupled or ac-coupled to the same common mode voltage (Figure 17) or any other voltage within the input voltage range.

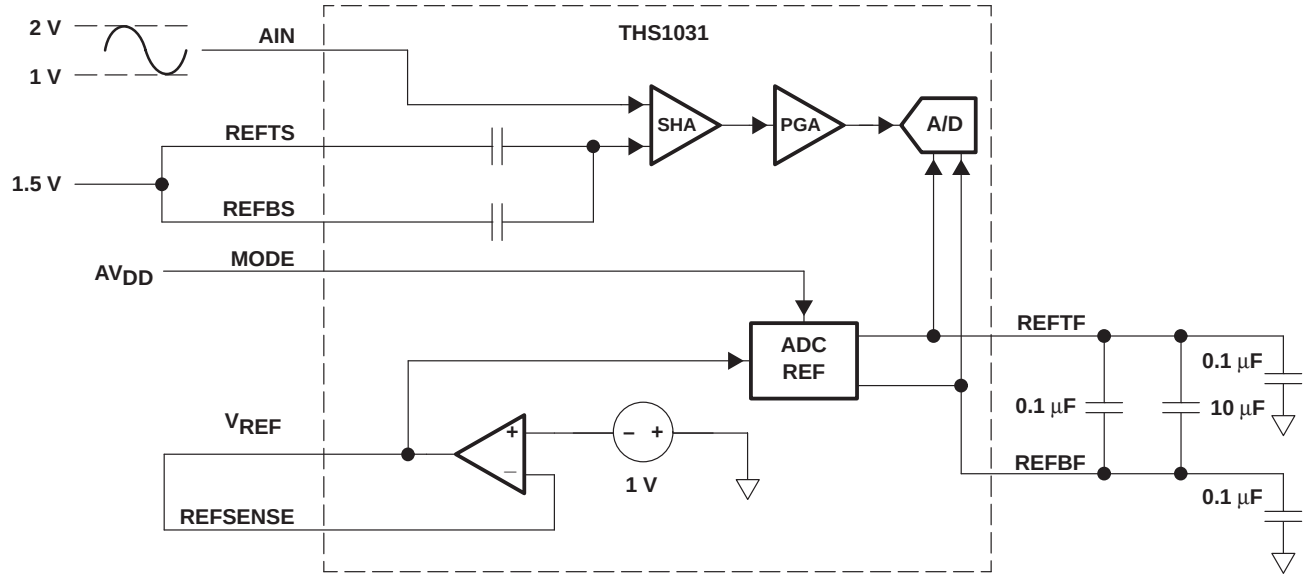


Figure 17. External Input Common Mode

PRINCIPLES OF OPERATION

analog input mode(continued)

- **Internal ADC Reference Mode With Common Mode Input $V_{REF}/2$**: The input common mode is set to $V_{REF}/2$ by connecting REFTS to V_{REF} and REFBS to AV_{SS}. The input signal at AIN will swing between V_{REF} and AV_{SS}.

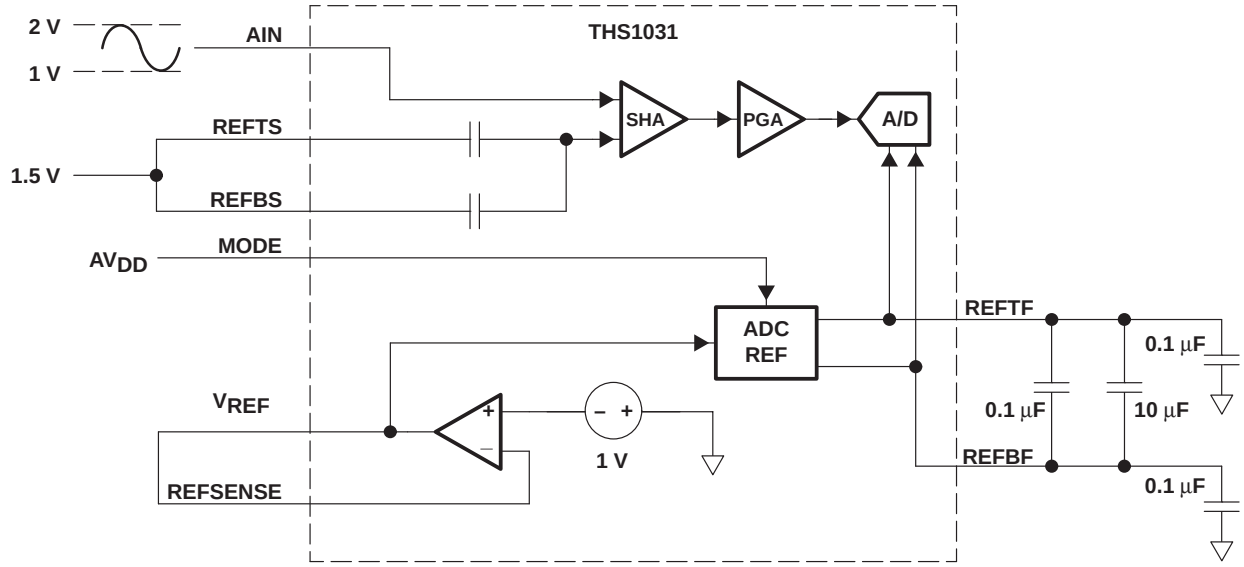


Figure 18. Common Mode Input $V_{REF}/2$ With 1-V Internal Reference

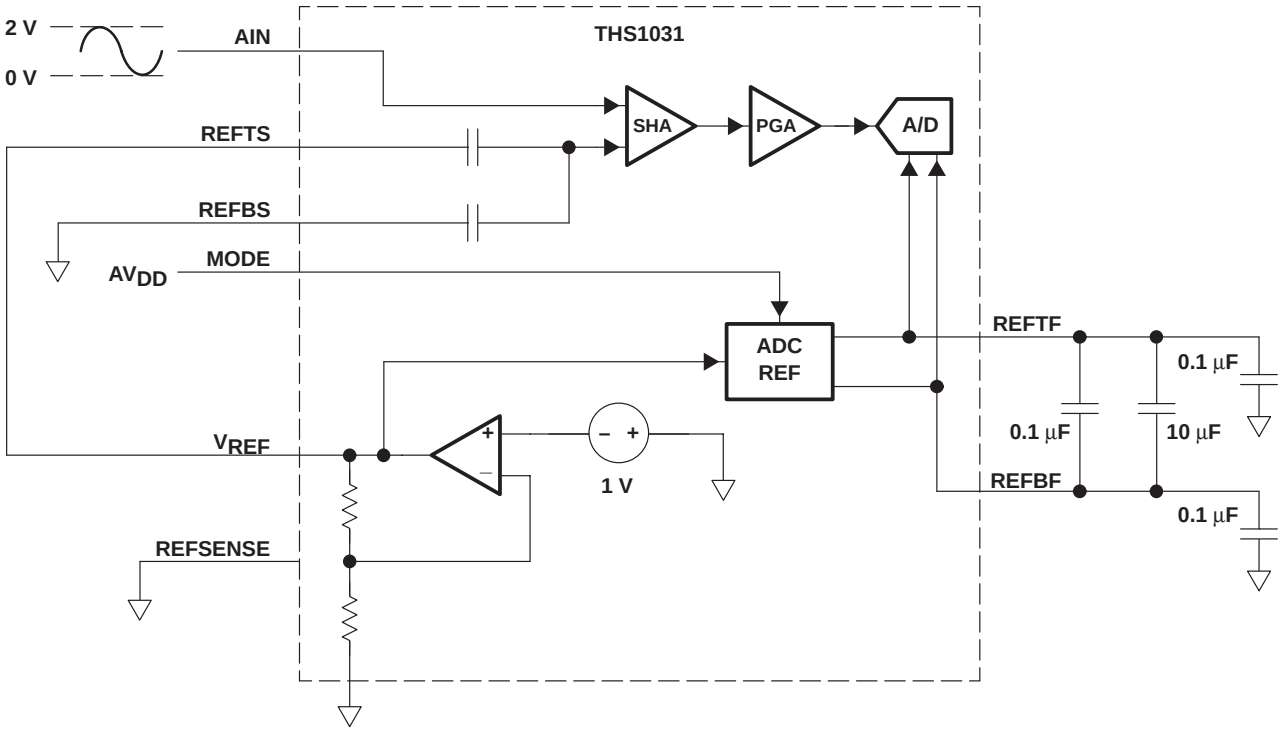


Figure 19. Common Mode Input $V_{REF}/2$ With 2-V Internal Reference

PRINCIPLES OF OPERATION

analog input mode(continued)

differential input

In this mode, the first differential input is applied to the AIN pin and the second differential input is applied to the common point where REFTS and REFBS are tied together. The common mode of the input should be set to $AV_{DD}/2$ as shown in Figure 20. The maximum magnitude of the differential input signal should be equal to V_{REF}.

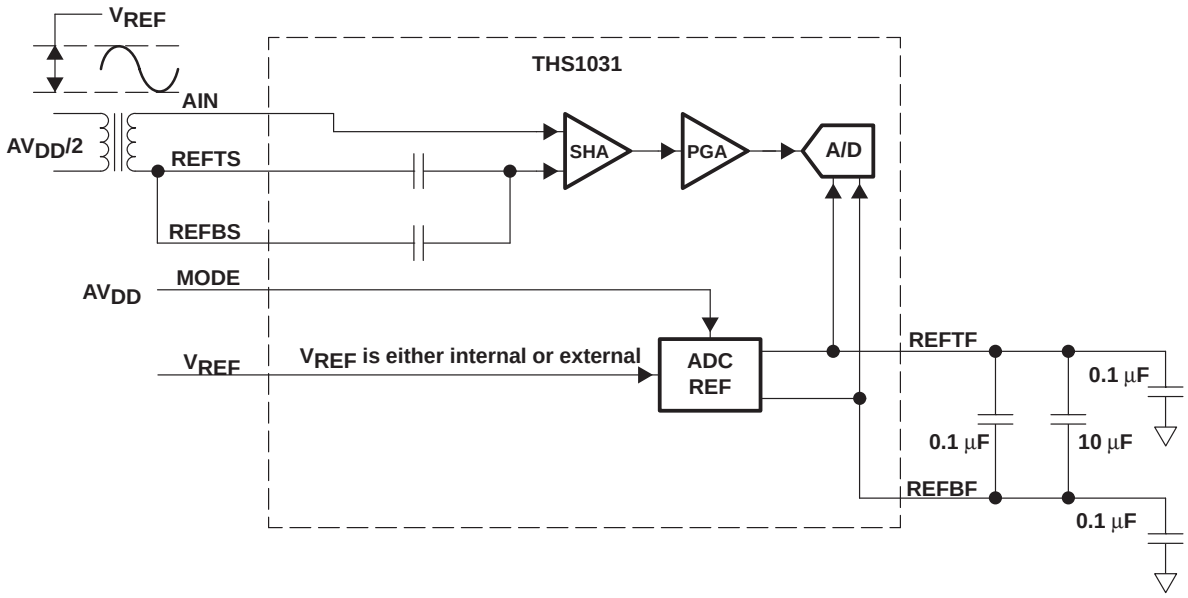


Figure 20. Differential Input

digital input mode

The THS1031 contains 4 registers: two CLAMP registers, a CONTROL register, and a TEST register. The TEST register is reserved for test purposes. Binary data can be written into the CLAMP and CONTROL registers via I/O0–I/O9 by inserting an active-low write strobe to the WR input pin and an active-low signal to the OE input pin. This will disable the ADC's output bus. The two MSBs of each register are address bits. For example, set bit 9 and bit 8 to 00 to select the clamp register 1. Set bit 9 and bit 8 to 01 to select the clamp register 2.

clamp registers

The internal digital clamp circuit uses a 10-bit DAC to convert the 10-bit digital value into the analog clamp level in which the clamp register 1 contains 8 LSBs of DAC(7:0). The clamp register 2 contains two MSBs of the DAC(9:8). **DAC(9:8)** *(Default = 00):* For clamping purpose**,** the entire range of voltage reference V_{REF} is divided into 4 quarters which can be selected by bit 0 (DAC8) and bit 1 (DAC9) in the clamp register 2. The user can clamp to any of 256-dc levels within each quarter determined by the 8-bit content of the clamp register 1. Figure 21 shows how the DACs 10-bit digital input map to the analog clamping range from 0 V to V_{REF}.

- **Clamp Register 1**

9	8	7	6	5	4	3	2	1	0
0	0	DAC7	DAC6	DAC5	DAC4	DAC3	DAC2	DAC1	DAC0

- **Clamp Register 2**

9	8	7	6	5	4	3	2	1	0
0	1	X	X	X	X	X	X	DAC9	DAC8

PRINCIPLES OF OPERATION

digital input mode (continued)

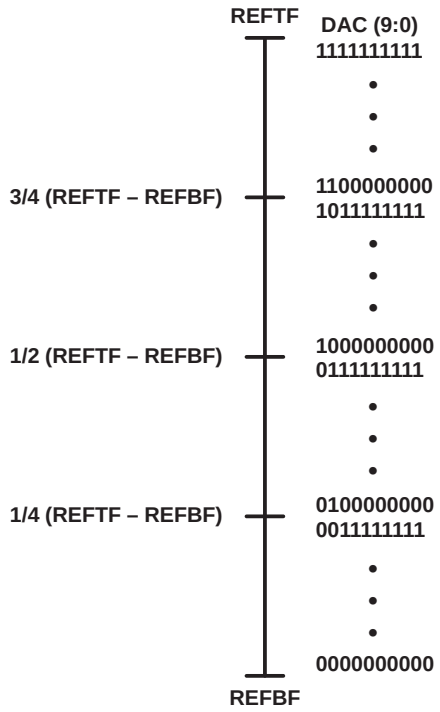


Figure 21. Digital Clamp Input Range

control register

9	8	7	6	5	4	3	2	1	0
1	0	X	Clamp Disable	Bin/2's Output	INT/EXT Clamp	Power Down	PGA2	PGA1	PGA0

- **Clamp Disable***: (Default = 0)* Set bit 6 to 1 to disable the internal clamp amplifier for power savings.
- **BIN/2s Output:** *(Default is straight binary*) Set bit 5 to 0 to set the output data format to straight binary or set bit 5 to1 to set the output data format to 2s complement.
- **INT/EXT Clamp:** (*Default = 0)* Set bit 4 of the CONTROL register to 0 to select the external analog clamp or set bit 4 to 1 to select the internal digital clamp whose clamp level is defined in the clamp register described above.
- **Power Down:** (*Default = 0)* Set bit 3 of the CONTROL register to 1 to power down the THS1031.

PRINCIPLES OF OPERATION

digital input mode (continued)

- **PGA(2–0):** (*Default = 001)* 3-bit gain for programmable gain amplifier can be set as indicated in the following table:

PGA[2–0]	GAIN
000	0.5
001	Unity gain
010	1.5
011	2.0
100	2.5
101	3.0
110	3.5
111	4.0

test register (reserved)

9	8	7	6	5	4	3	2	1	0
1	1	X	X	X	X	X	X	X	X

digital output mode

- **3-State Output:** The digital outputs can be set to high-impedance state by applying a Hi logic to the $\overline{OE}$ pin.
- **Output Format:** Defined by bit 5 of the CONTROL register. The output format is straight binary if bit 5 set to 0. The output format is 2s complement if bit 5 is set to 1. *The default format is straight binary.*

clamp operation

The THS1031 ADC features an internal clamp circuit for dc restoration of video or ac coupled signals. The clamp input level can come from either an external source or an internal digital clamp circuit containing a 10-bit DAC and clamp register.

- **External Clamp Input:** To enable the external clamp input source, use the default state on power up or write a 0 to bit 4 of the PGA/CONTROL register. This will connect the switch SW2 to the CLAMPIN pin. The clamp amplifier will then servo the voltage at the AIN pin to be equal to the clamp voltage applied at the CLAMPIN pin. After the desired clamp level is attained, the switch SW1 is opened by taking CLAMP back to logic low. Ignoring the droop caused by the input bias current, the input capacitor CIN will hold the DC voltage at AIN constant until the next clamp interval. The input resistor RIN has a minimum recommended value of 10 W, to maintain the closed-loop stability of the clamp amplifier.
- **Internal Programmable Digital Clamp Input:** The THS1031 ADC features a programmable digital clamp circuit to set more precise clamping level to 1-LSB accuracy for dc restoration of video or ac coupled signals. Figure 22 shows the internal clamp circuitry and the external control signals needed for the digital clamp operation. To enable the digital clamp input source, write a 1 to bit 4 of the CONTROL register which will connect the switch SW2 to the output of the 10-bit clamp DAC. In the CLAMP register, bit 0 to bit 7 are used to set the clamp level input to the 10-bit DAC and bit 6–7 are used to select one of 4 equal clamping voltage sub-ranges as described in the description of CLAMP REGISTER for digital input mode. The clamp amplifier will then servo the voltage at the AIN pin to be equal to the clamp voltage applied at the CLAMPIN pin. After the desired clamp level is attained, the switch SW1 is opened by taking CLAMP back to logic low. Ignoring the droop caused by the input bias current, the input capacitor CIN will hold the dc voltage at AIN constant until the next clamp interval. The input resistor RIN has a minimum recommended value of 10 W, to maintain the closed-loop stability of the clamp amplifier.

PRINCIPLES OF OPERATION

clamp operation (continued)

- **Clamp and Droop Analysis**

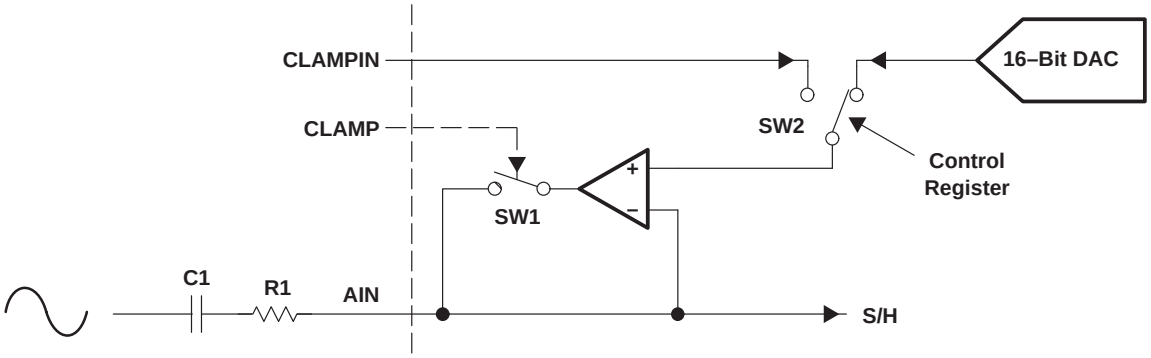


Figure 22. Clamp Operation

- **Clamp Acquisition Time:** Figure 22 shows the basic operation of the clamp circuit in which the ac input signal is passed through an RC coupler.

The acquisition time when the switch is closed will equal a: $T(acq) = C_i.R_i \ln(Vc/Ve)$(Eq.1)

In case of composite video, typical input Ri = 20 Ω. In a video clamping application, the droop is a critical parameter and thus the input capacitor should be sized to allow sufficient acquisition time of clamp voltage at AIN within the CLAMP interval, but also to minimize droop between clamping intervals. Typically, C_i = 1μF

By applying equation 1 above, the following examples apply to an NTSC composite video signal:

- The acquisition time needed to clamp 1-V input level to black level (0.340 Vdc) is about 130 μs.
- The acquisition time needed to clamp 2-V input level to the white level (1 Vdc) is about 140 μs.
- The acquisition time needed to clamp 3-V input level to the sync level (0.288 Vdc) is about 160 μs.

droop

The voltage droop is the voltage change across the input capacitor C_i by the bias current as follows:

$$dV = (I_{bias}/Ci)(t)$$

where t = elapsed time between clamping intervals

The bias current depends on the sampling rate. For a sampling rate of 30 MSPS and a typical input capacitance of 1 pF, the input resistance is

Rs = 1/(Cs.Fs) = 1/(1 pFx30 MHz) = 33 kΩ

For 1-V input range and clamping period = 64 μs, the max bias current will equal I_{bias} = 0.5 V/33 kΩ = 15 μA:

dV = (15 μA/1 μF)(64 μs) = 0.96 mV

For 1-V input range and clamping period = 64 μs, the max bias current will equal I_{bias} = 0.5 V/33 kΩ = 15 μA:

dV = (15 μA/1 μF)(64 μs) = 0.96 mV

For 2-V input range and clamping period = 64 μs, the max bias current will equal I_{bias} = 1.0 V/33 kΩ = 30 μA

dV = (30 μA/1 μF)(64 μs) = 1.9 mV

clamp operation (continued)

requirements

For a single direct source of NTSC video,

- The initial clamp acquisition time needs to be between 130 μs and 160 μs to set the input dc level within 1 mV accuracy.
- The clamp pulse at CLAMP is recommended to be 2 μs (typ).
- The droop voltage needs to be compensated within one clamping period of 64 μs for 1 V and 2 V. Input ranges are 1 mV and 1.9 mV respectively which are less than 1 LSB.

power management

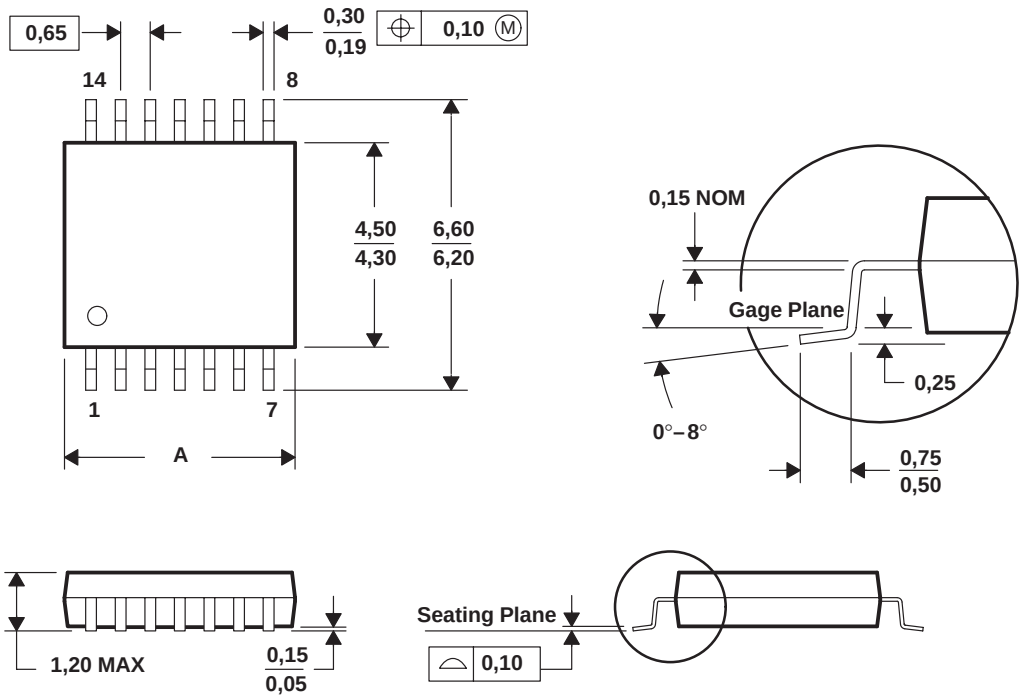
Upon power up, the THS1031 is put in the default mode. In the default mode, the PGA (PGA bypass) and the clamp DAC are powered down which adds to the device's flexibility. The users need not incur the penalty of having to provide power for a certain section if it is not necessary to their design.

When bit 3 of PGA/control register is set to 1, the entire device is powered down. The ADC will wake-up in 400 ns (typ) after the bit 3 is reset.

MECHANICAL DATA

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

14 PINS SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

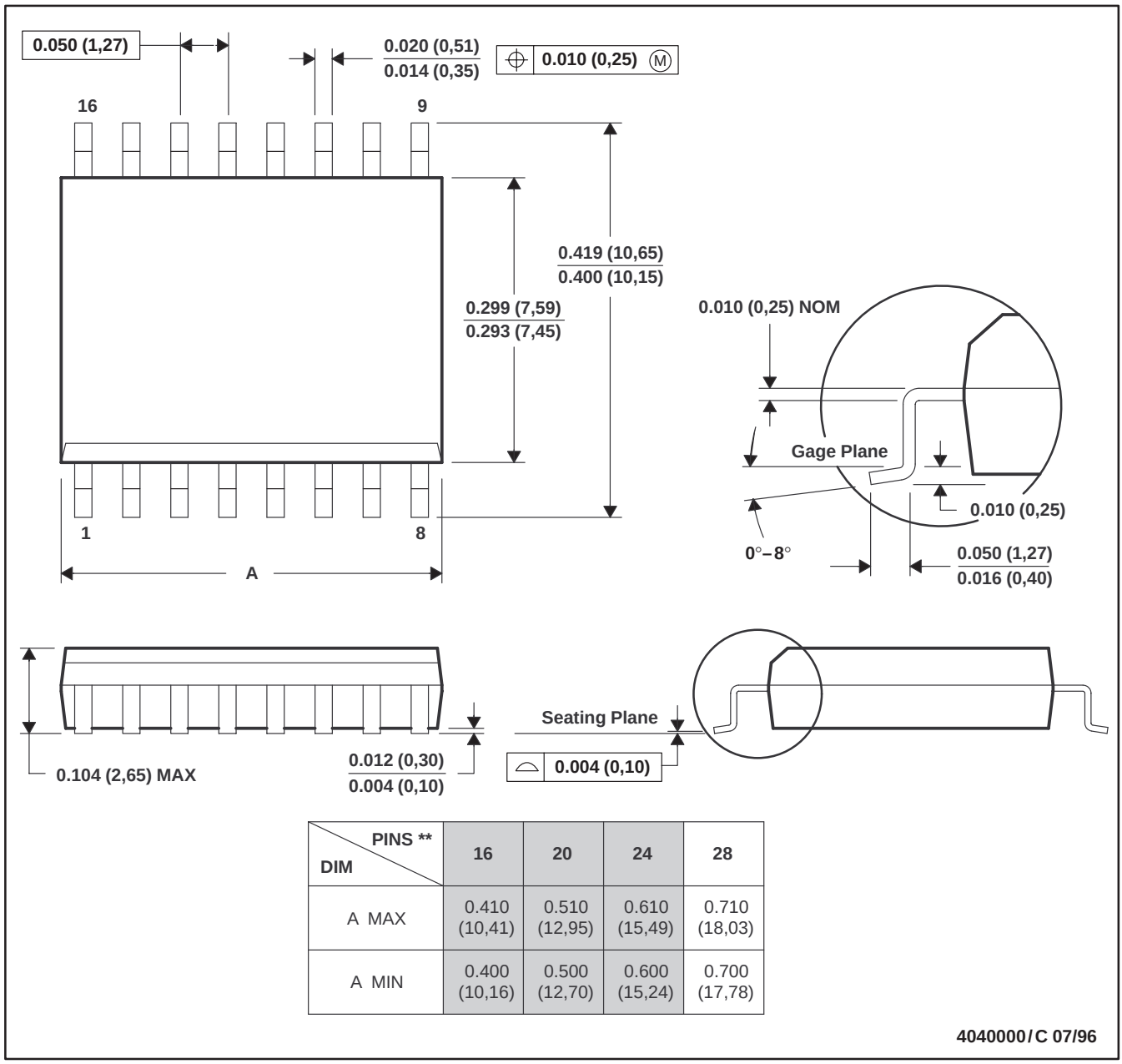
4040064/F 01/97

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

MECHANICAL DATA

DW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

16 PINS SHOWN



DIM \ PINS **	16	20	24	28
A MAX	0.410 (10,41)	0.510 (12,95)	0.610 (15,49)	0.710 (18,03)
A MIN	0.400 (10,16)	0.500 (12,70)	0.600 (15,24)	0.700 (17,78)

4040000/C 07/96

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-013

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